UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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OFFICE OF
WATER

MEMORANDUM JAN 5 2000

SUBJECT: Well Classification Guidance for Downhole Hydrocarbon/Water Separators; UIC Program Guidance #82

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(4601)

TO: Water Management Division Directors
EPA Regions I-X

What is the nature of this action?

Underground Injection Control (UIC) program offices in several Regions have requested clarification pertaining to a certain family of "new technology devices" which are used to: 1) enhance oil and/or natural gas production and 2) decrease entrained salt water volumes brought to the surface in connection with this hydrocarbon production. These "new technology devices" have been termed *downhole separators*, deriving their name from their function of physically separating water and hydrocarbons from each other near the production interval in oil and/or gas producing wells (i.e. "downhole"). The water separated from the production stream is, in turn, introduced into a different interval in the well without being brought to the surface with the produced hydrocarbons. There initially existed some confusion about how to classify wells utilizing these downhole separator devices, since the technology post-dates the existing UIC regulations and the Safe Drinking Water Act (SDWA). This memorandum serves as a guidance for classifying these type of underground injection operations as Class II enhanced recovery wells (II-R).

What is "Downhole Separation"?

Known informally in oil-producing states and within the industry as "downhole separation," this new technology uses pumps which are placed inside wells which also produce oil and/or gas. The more conventional injection technology uses injection pumps at the land surface outside of the well. For years, hydrocarbon production operations have relied on downhole pumps to produce oil, natural gas, and water from wells that will not flow to surface under natural pressures. Recently, pumps have been developed to allow fluids which have been separated from the inflowing stream of produced fluids by centrifugal or gravitational methods to be pumped through an additional tubing in the wellbore, into a different formation. In the same well, a separate part of the pump lifts the remaining fraction of fluids containing hydrocarbons and, usually, a very small amount of formation brine to the surface. The reversal in pump direction allows these pumps to be used for injection operations.

The oil and gas production industry has identified one particular use of this technology which promises benefits to the environment and reduces endangerment to underground sources of drinking water (USDW). It also eliminates the need for significant above-ground water handling facilities associated with the wells in question and the potential for surface spills associated with handling the waste water. Natural gravity separation will occur as oil, gas, and water are produced into the well. Water will separate and fall to the lowest point in the well, while oil and gas may be produced to the surface. This separation allows the oil and gas to be produced to the surface, with water remaining in the well. Proper placement of a downhole pump (or hydrocyclone system) in a well allows injection of this remaining water into geologic formations without the need to first produce the water to the surface.

The benefits to the environment are readily apparent. The water, in most cases brines having high concentrations of *total dissolved solids* (TDS), is not produced to the surface (through intervals containing USDWs), and the water does not require injection from the surface (again through intervals containing USDWs). Therefore, the risks posed by large volumes of these fluids passing USDWs both exiting and re-entering the well upon injection are minimized. In addition, surface brine disposal operations, which may be comprised of pumps, pipes, tank batteries, and other storage facilities may also be reduced in size and extent if not altogether eliminated. The potential for leaks and hence exposure to these fluids via fluid runoff to surface water and percolation and contamination of shallow ground water is also greatly reduced.

How does EPA determine the Classification of injection wells?

The Federal UIC regulations at 40 CFR §§144.6 and 146.5 describe the five classes of injection wells regulated by the UIC program. Pertaining to the issue at hand, 40 CFR §§144.6(b)(2) and 146.5(b)(2) both contain the same description of enhanced recovery Class II wells. These regulations define "Class II Wells to include wells which inject fluids...for enhanced recovery of oil or natural gas." The plain reading of this regulation suggests that two thresholds have been established (or need to be passed) for a well to meet this definition. First, does such a well inject fluid? Second, is the injection undertaken for the enhanced recovery of oil or natural gas? EPA's analysis of these points are as follows:

Do these wells inject a fluid?:

The wells utilize devices which separate oil and water downhole before either reaches the surface. The water fraction either flows by gravity or is pumped under pressure into a subsurface geological formation. The regulations also define "well injection" as the subsurface emplacement of "fluids" through a bored, drilled or driven "well;" or through a dug well where the depth of the dug well is greater than the largest surface dimension (40 CFR §144.3). The regulations also define an "injection well"as a well into which fluids are injected and an "injection zone" as a geological formation, group of formations or part of a formation receiving fluids through a well." Thus injection is tied to use of a well and emplacement of a fluid into a subsurface geological formation. Because the fluids in these wells are emplaced into an injection zone after removal from the production fluid stream by the downhole separators, these wells meet the first test of an enhanced recovery well.

Is the injection for enhanced recovery?:

The regulations and the preambles do not define "enhanced recovery" beyond the definitions cited above. The Bureau of Land Management (BLM) does, however have a definition of enhanced recovery in their rules for oil and gas and sulphur operations in the outer continental shelf, Section 250.2 Definitions: *"Enhanced recovery operations means pressure maintenance operations, secondary and tertiary recovery, cycling, and similiar operations which alter the natural forces in a reservoir to increase the ultimate recovery of oil or gas."*

One methodology to determine whether or not hydrocarbon production is "enhanced" is to look at data derived from the experimental use of downhole separators and consider whether or not these devices truly enhance the production of hydrocarbons.

As of the date of this memorandum, data from all 38 known wells utilizing these devices indicate that the average increase in oil production rate was 48% and the average decrease in water production rate was 85%. (***Note:*** *These existing wells were located in Canada and in primacy states which have already approved using the technology).* The raw numbers to derive these percentages are taken from the total of all 38 wells which installed a downhole separator. These raw numbers are shown in Table 1.

Table 1	**Prior to downhole separator (barrels produced per day)**	**After downhole separator (barrels produced per day)**	**Percent Change**
Oil	1,194	1,766	+48%
Water	31,348	4,614	-85%

Further, the same data can be used to calculate how many of these wells experienced an increased hydrocarbon production rate or efficiency. Of these test wells having data from both before and after installation of downhole separators, 63% of the wells experienced an increase in hydrocarbon rate, while virtually every well experienced a decrease in water production rate. Table 2 shows the raw numbers used to derive these figures.

Table 2	**# Wells with Before and After Data**	**# Wells with Increased Production**	**Percent Change**
Oil	30	19	+63%
Water	29	0	-100%

Thus, two conceptual standards for enhanced oil recovery, as outlined in the definition of "enhanced oil recovery" given in the BLM's Onshore Regulations for Oil and Gas Production, are met: (1) more hydrocarbons are produced after installation of a downhole separator, and (2) with a marked decrease in water production, the efficiency of hydrocarbon production is increased, contributing toward a more efficient, cost effective recovery of oil or gas. Use of downhole separators both increases total hydrocarbon production and increases efficiency in hydrocarbon production by the result of less water produced at the surface which greatly reduces the pumping costs because only the oil and a small amount of water must be brought to the surface. This results in a decrease in the normal associated water handling and disposal costs. Also, these wells will produce hydrocarbons for a longer period of time, resulting in greater total hydrocarbon recovery. The lower production and above ground treatment costs will increase well life because the well can produce less oil per day with profits exceeding production and/or separation costs. Thus, the second test for a Class II enhanced recovery well is met: these wells do lead to enhanced recovery of hydrocarbons.

Although the above data set is representative for an oil production scenario, it is the Agency's understanding, based on the similarity in the cost reduction due to lower production costs that similar enhanced production may be realized for natural gas production wells using downhole separators. Water removal in a wellbore increases the gas migration to surface.

How are wells using "Downhole Separation" classified?

Based on information provided EPA, and on the above well data, EPA believes the use of downhole separators in a well under the circumstances described in this guidance allows the well to meet the regulatory criteria for a Class II enhanced recovery well. Therefore, the Federal regulations applicable to Class II wells apply to wells using downhole separators under direct implementation Class II UIC programs. Directors of State §1425 UIC programs should determine whether or not a particular well belongs within this classification for the purposes of the state programs they administer. The Director may make such a determination on a case-by-case basis or generically for a specific type of well construction that differs from this guidance where appropriate. EPA requests that any such determinations be reported to the appropriate Regional Office.

Were there any questions raised during the development of this guidance?

During the development of this guidance, EPA provided copies of the draft document to the states, members of the regulated community, the public, and the environmental community. Several questions and concerns were raised by the environmental community. The concerns are summarized below in bold, followed by responses to the question or concern.

The downhole separation technology does not allow for the performance of normal mechanical integrity testing. The lack of ability to perform regular mechanical integrity testing is a concern.

Under 40 CFR 144.28(f)(4) or 144.51(q)(3)**,** injection wells are allowed to operate without demonstrations of mechanical integrity if an alternative demonstration can be made to show that there is no movement of fluids into or between USDWs. The demonstration which can be made for these wells is that the conditions which normally prevent production wells from allowing movement of fluids into or between USDWs also exist when downhole separation allows production wells to be simultaneously used as disposal wells. We believe that such a demonstration can be made in every case. Why production wells do not normally pose risks of contamination to USDWs is described below.

If such technology is to be utilized, how will EPA establish a regulatory program that will specifically require testing in place of the mechanical integrity testing?

EPA does not believe that a new regulatory scheme is needed for mechanical integrity testing of downhole separation wells. Defining wells using downhole separation as enhanced oil recovery (EOR) wells brings them within the existing regulatory scheme. Because it is necessary to use an alternative demonstration (40 CFR 144.28 (f)(4) and 40 CFR 144.51(q)(3)) for wells which cannot demonstrate mechanical intergrity, the existing regulations can ensure that wells using downhole separation do not threaten USDWs. For instance, EPA expects that the Director will require an initial testing of the well's casing for leaks and the absence of fluid movement adjacent to the casing prior to the installation of the separator. The Director may also require that the casing be pressure tested following any workover that results in the removal of the separator. In addition, the Director may require that the fluid level depth in the well's open annulus be measured at an appropriate frequency to ensure that the basis for the decision remains valid.

In some cases, it appears that the annular space is utilized as part of the process in the downhole area. This results in the loss of one layer of protection. What requirements will be implemented to replace the loss of one layer of protection?

A key element of the downhole separation technology is that during operation of the oil/water separator, fluids in the wellbore are drawn downward away from USDWs . In order to maintain a constant flow of oil and water into the casing, it is necessary to operate the pump which lifts the oil to the surface and simultaneously injects the produced water into the injection zone; thereby drawing down the fluids in the annular space. This drawdown of the wellbore fluids results in precisely the same protection that a tubing and packer provide: namely, separation of the annular fluids from USDWs. Because of this operational phenomenon, EPA believes that the downhole separator will result in the same level of protection provided by tubing and packer.

During temporary times in which the downhole separator is not active, the regulations at 40 CFR 144.28(f)(4) or 144.51(q)(3) still apply. These regulations require that an alternate demonstration must be made in lieu of the normal mechanical integrity testing requirements. As explained above, EPA expects that testing, such as periodic pressure testing of the casing and fluid level monitoring in the annulus, will occur. These types of assurances also result in the equivalent protection provided by a tubing and packer: wellbore fluids are demonstrated to be separated from USDWs.

Why does the guidance focus only on enhanced recovery Class II rather than injection or

enhanced recovery as appropriate? In some cases, it appears that the technology may be used for enhanced recovery, but in other cases it may be used strictly as injection for disposal. Shouldn't the guidance separate the two uses of the technology?

After reviewing the regulations pertaining to the classification of wells, EPA determined that the fluids generated by this technology do not meet the strict definition of fluids that are injected into a Class II disposal injection well. The regulations define disposal as the re-injection of fluids brought to the surface in the course of oil and/or gas production. Because waste fluids separated down hole and injected are not brought to the surface, wells using downhole oil-water separation can not be regulated as Class II disposal wells. However, EPA decided that such wells meet the classification of enhanced oil recovery wells and can be regulated as Class II because the use of downhole separation allows more oil to be produced to the surface given the other elements of the production system, improves economics, and thereby allows the production of more oil on both a daily and cumulative basis. These increases in ultimate production constitute enhanced oil recovery.

Does the use of the technology increase the potential for pressuring up the injection formation and allowing for the migration of waste up the outside of the well casing?

This is the case with all injection for disposal and is the principal reason why we decided that this type of injection must be regulated. EPA determined that the existing UIC regulations were appropriate to address any potential problems. Application of the program elements which address the issue of pressure increase in conventional injection wells will be used to prevent problems in wells using downhole separation. In most cases, the injection reservoir will be below the producing reservoir. In such a case, the producing zone will serve as a sink for upward moving water. The water will probably be produced, along with other formation water, into the well. It is very rare that pressure in a producing reservoir is not reduced due to the removal of hydrocarbons and water. Therefore, it is unlikely that the reservoir will support a column of water which will reach a height sufficient to endanger underground sources of drinking water. In such a well it is impossible for the increased pressure in the injection zone to threaten USDWs. Once again, wells using downhole separation should be regulated under the UIC program, because there will also be some wells in which the injection zone is above the producing zone, simply because of the absence of good disposal zones below the producing zone, inability to drill completely through producing zones without allowing high water production from water-filled zones immediately below the producing zone, and/or other causes. The UIC regulations allow the imposition of requirements which will protect USDWs on a case-by-case basis.

Who do I contact for more information?

For further information, or questions relating to this guidance, please contact Chuck Tinsley, EPA Region VIII, at 303-312-6260, or Bruce Kobelski, EPA HQ-OGWDW, at 202-260-7275.

Disclaimer

This document provides guidance to EPA Regions and States exercising responsibility under the SDWA concerning UIC well classification determination for wells with downhole hydrocarbon separators. It also provides guidance to the public and the regulated community on how EPA intends to exercise its discretion in implementing the statute and regulations regarding such classification. The guidance is designed to implement national policy on these issues. The document does not, however, substitute for the SDWA or EPA's regulation; nor is it a regulation itself. Thus, it cannot impose legally-binding requirements on EPA, States, or the regulated community, and may not apply to a particular situation based upon the circumstances. EPA may change this guidance in the future.